

**Texas Commission on Environmental Quality  
New Technology Research & Development (NTRD) Program  
Monthly Project Status Report**

**Contract Number:** 582-11-13472-2019

**Grantee:** Transportation Power, Inc. (Transpower)

**Report for the Monthly period:** 11/10/12 – 12/07/12      **Date Submitted:** 12/09/12

**Section I. Accomplishments**

*Provide a bulleted list of project accomplishments as well as a description of their importance to the project.*

- Durability testing of Tractor #1 continued. Due to continuing difficulties in perfecting our automated manual transmission (see below), the tractor was locked into third gear and tested extensively in this one gear. Most testing was performed with a container loaded to 20,000 pounds (lb). (see Figure 1).



**Figure 1: Tractor #1 during testing while pulling a container loaded to about 20,000 lb.**

- Commissioning of Tractor #2 was initiated. This work included checking fluid systems for leaks and initiation of low-voltage testing of the central control module.
- Efforts to perfect the automated manual transmission (AMT) continued. The shift controller acquired from Mastershift was completely rebuilt with new control boards and embedded software developed by TransPower, and limited success was achieved performing shift functions on a test stand.

*Indicate which part of the Grant Activities as defined in the grant agreement, the above accomplishments are related to:*

- The first accomplishment relates to Task 2.3.1, *“The PERFORMING PARTY will conduct at least 3 weeks of drive testing of Tractor 1 in simulated and/or actual service.”*
- The second accomplishment relates to Task 2.3.2, *“The PERFORMING PARTY will conduct at least 2 weeks of drive testing of Tractor 2 in simulated and/or actual service.”*
- The third accomplishment relates to Task 2.2.3.1, *“The PERFORMING PARTY will update the electric drive system required components for the second tractor, if necessary, to reflect any changes in components or parts deemed necessary during initial road testing of Tractor 1 in Task 2.3.1;”* and Task 2.3.1.2, *“The PERFORMING PARTY will optimize the drive system to maximize energy efficiency while meeting performance requirements and maintaining driver comfort.”*

## Section II: Problems/Solutions

*Problem(s) Identified: Report anticipated or unanticipated problem(s) encountered and its effect on the progress of the project*

- a) As discussed in previous reports, TransPower engineers discovered a software bug in the control box for the automated shifter that caused unintended behavior. Further testing of the shift controller raised concerns about the durability of the control mechanisms.
- b) During more rigorous drive testing of Tractor #1, the drive system periodically shut down due to high temperature readings at the main drive motor.

*Proposed Solution(s): Report any possible solution(s) to the problem(s) that were considered/encountered*

- a) After more than two months of efforts to make Tractor #1 shift reliably with the automated manual transmission, it was determined that the Mastershift controller is completely inadequate for the shifting accuracy and reliability required for these tractors. Since Tractor #1 was shown to perform adequately using just one gear, there are two potential solutions to this problem: place the tractors into service using just one gear, or completely redesign the shift control mechanism.
- b) Possible solutions to the high motor temperature readings were to take extra steps to cool down the motor or determine if the temperature readings were false.

*Action(s) Conducted and Results: Describe the action(s) taken to resolve the problem(s) and its effect*

- a) While Tractor #1 has shown that, even in one gear, it can function pulling a 20,000 lb. load for approximately ten hours, at speeds comparable to speeds achieved by conventional tractors, we consider delivering the tractor to HEB locked into a single gear as a last resort. We continue to have a strong preference for resolving the automated shifting problem because this is a vexing problem for all heavy-duty electric and hybrid-electric vehicles, and perfection of the automated manual transmission would advance the state of the art in design of such vehicles in very important ways. Alternative shifting approaches used in competing vehicles either fail to meet the demanding performance requirements of these heavy vehicles, or consume so much power that battery energy is depleted too rapidly for vehicles to be of practical use. In addition, we believe the control problems we have experienced can be addressed with minimal risk if we simply devote enough effort to writing more robust software and utilizing more rugged control boards. Therefore, we have decided to continue working on the automated manual transmission at least until the end of this year, with the goal of being able to deliver both tractors to HEB with the ability to use at least two gears by sometime in January 2013.
- b) Fortunately, examination of the thermal shutdown problem revealed that the inverter-charger unit (ICU) was merely misreading the drive motor temperatures because its reading of the motor thermistors had not yet been calibrated. Adjustment of the ICU calibration quickly remedied this problem.

### **Section III. Goals and Issues for Succeeding Period:**

*Provide a brief description of the goal(s) you hope to realize in the coming period and identify any notable challenges that can be foreseen*

Goals for the next reporting period (ending January 10, 2013) include:

- Complete redesign of the automated manual transmission and perfect, at minimum, a capability for shifting between two gears on both tractors.
- Complete durability testing of Tractor #1, including one week of independent testing with Southern California Edison.
- Complete or nearly complete durability testing of Tractor #2.
- Begin preparations for delivery of both tractors to HEB before the end of January 2013.

The most notable challenge that can be foreseen in completing these objectives is to perfect the automated manual transmission, which remains the sole major technical challenge to completion of this project. While this technology remains a concern, the results of recent drive tests of Tractor #1 in just one gear have been exceptional. This means we always have the fallback position of delivering both tractors to HEB locked into a single gear, a model in which we believe they would meet HEB's minimum requirements. However, given the huge payoff that would be gained if the automated manual transmission can be perfected, in terms of achieving a greater range of performance and longer run time, we feel it is worth devoting at least another month to working on this technology.

Date: 12/9/12

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*Authorized Project Representative's Signature*

**NOTE:** *Please attach any additional information that you feel should be a part of your report or that may be required to meet the deliverable requirements for tasks completed during this reporting period.*